B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, APRIL – MAY 2011

MATERIALS SCIENCE AND ENGINEERING BRANCH

SIXTH SEMESTER - (REGULATION 2004)

ML 381 – BIO AND SMART MATERIALS

Time: 3 hr Max. Mark: 100

PART- A (10X2 = 20 Mark)

Define the following:

1. Biocompatibility.
2. Piezoelectricity
3. Training
4. Thromogenicity
5. Tissue Engineering
6. Intelligent materials
7. Bingham body model
8. Secondary moulding
9. Stress shielding
10. Therapeutic index

PART- B (5 X16 = 80 Mark)

11. Brief on the following:

    (i) TWO method of Non-thrombogenic treatments. (6)

    (ii) Materials response to biological system (10)

12. (a) (i) Describe the principle behind use of rheological fluid (6)

    (ii) Brief on characteristics and design parameters of electro-rheological fluids. (10)

    (OR)

    (b)(i) Explain the mechanism involved in piezoelectric materials. (12)

    (ii) What do you mean by hybrid smart structures? (4)

13. (a) Brief on mechanism of shape memory effect.

    (OR)

    (b) Brief on various applications of shape memory materials.

12b. i) Describe with a neat sketch 'Elastic after effect' and explain the reasons for this effect. (6)

ii) Determine the maximum crack size that can be tolerated in a sheet of a high tensile material which has a tensile yield stress of 1100 MPa and a toughness of 25 KJ/sq.mtr. if the design safety factor is 1.5. Assume E = 208 Gpa. (10).

13a. i) Describe in detail, the various theories on fatigue fracture of materials and the factors affecting fatigue life. (8)

ii) Explain clearly with a neat sketch, the following: a) Effect of overload on constant amplitude fatigue. b) Fatigue damage. (8)

(OR)

13b. i) List the basic aspects of dynamic crack growth. Explain in detail, crack branching and crack arrest. (8)

ii) Determine the fracture stress of a glass plate if it contains a series of micro cracks with a maximum dimension of 10μ. What would be the likely fracture stress for the glass plate if a fine scratch with a depth of 0.3 mm was made on the surface? E=70 Gpa and surface energy 0.63 J/sq.mtr for glass. (8)

14a. i) Discuss in detail the effect of thermal stresses in crack growth stability in fracture. (8)

ii) A Ferritic-pearlitic steel plate of large size is having an edge crack of length 3.1 mm under a constant amplitude cyclic bond having σ_{max} = 310 MPa and σ_{min} = 172 MPa. Determine a) propagation life up to failure and b) propagation life if the crack length is not allowed to exceed 25 mm.

For ferritic-pearlitic steel, K_{IC} = 165 MPa$\sqrt{m}$; $da/dN = 6.8X10^{-12} (\Delta K)^{3.0}$ (8)

(OR)

14b. i) Explain in detail how thickness of a material plays a dominant role in the designing of components. (8)

ii) Explain in detail, how environment assists in crack growth. Also explain in detail the major factors that influence environment-assisted fracture. (8)

15a. i) What is J-Integral? Explain in detail, how it can be useful to characterize materials exhibiting Elastic-plastic behavior near the crack tip. (8)

ii) A steel plate with a through thickness crack of length 2a = 20 mm is subjected to a stress

of σ = 400 MPa normal to the crack. If σ_{YS} of steel is 1500 MPa, what is the plastic zone size and the SIF for the crack? Assume the plate to be infinite in dimensions. (8)

(OR)

15b. i) How is crack propagation rate determined for a variable amplitude fluctuating load? (6)

ii) The Paris law of fatigue growth of a crack is known to have the form $da/dN = C(\Delta K_I)^3$. Where 'a' is in metre and ΔK_I in MPa$\sqrt{m}$. The central crack initially of length a = 4 mm grows to a = 5 mm in 2000 load cycles when a constant amplitude fluctuating load is applied with σ_{max} = 180 MPa and σ_{min} = 100 MPa. Determine the life of component beyond 5 mm if the same amplitude load continues on the component and the maximum allowable crack length in the damage tolerant design is a = 25 mm.